

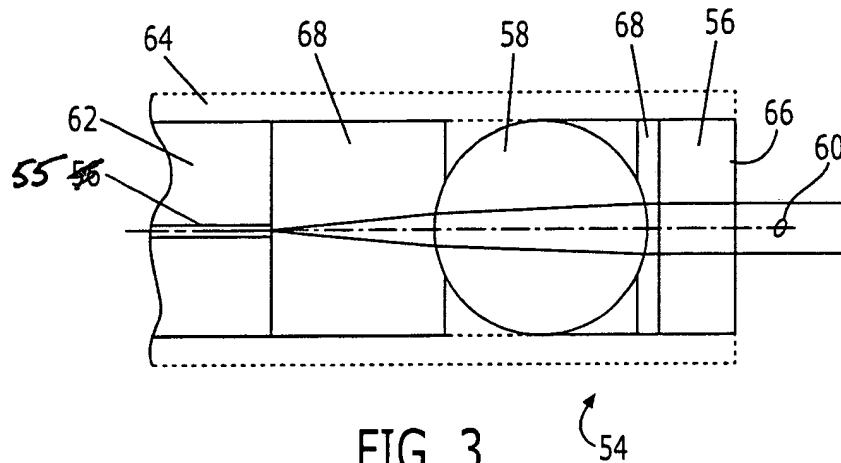
Appln. No. 10/657,403

Amendment dated April 17, 2006

Reply to Office Action of January 24, 2006

Amendments to the Drawings:

With the consent and approval of the Examiner, Applicants propose to amend Fig. 3 as shown in red in the following sketch:



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Remarks/Arguments

This Amendment is responsive to the Office Action mailed January 24, 2006 and April 10, 2006.

The Office Action of April 10, 2006 noted certain informalities in the Amendment filed on April 3, 2006. This Corrected Amendment corrects those informalities. More particularly, this Corrected Amendment: (1) shows the changes to the amended paragraphs in the specification, (2) places the Abstract on a separate page, and (3) labels the new drawing as a "Replacement Sheet".

The Examiner's comments with respect to the previous election in response to the restriction requirement is noted. It is understood that this application has been examined with respect to the subject matter of claims 1-12, and that claims 13-24 have been withdrawn from further consideration at this time, pending the allowability of a generic or linking claim. In paragraph 1 of the Office Action, the Examiner appears to have made an obvious typographical error. More particularly, she has stated that "claims 1-12 will be treated as one invention and claims 12-24 are withdrawn from further consideration pursuant to 37 CFR 1.142(b)". The double inclusion of claim 12 appears to be a simple typographical error. The Examiner is understood to have examined claims 1-12, and claims 13-24 are understood to have been withdrawn from further consideration at this time.

This Amendment makes a number of changes to the specification, amends a drawing figure, and makes a number of clarifying amendments to claims 1-12. These various aspects are discussed below.

Amendments to the Specification

As indicated above, this Amendment makes a number of changes to the specification. Most of these changes are self-explanatory, and are simply intended to improve the grammar and readability of the specification. For example, compound words have been hyphenated, and various clauses have been set off by commas.

The compound word "optically flat" has been hyphenated wherever encountered.

As indicated above, the foregoing changes to the specification are intended to hyphenate compound words, and to generally improve the grammar and readability of the specification. Suffice it to say here none of the changes seek to add "new matter", the introduction of which is prohibited by 35 U.S.C. §132. The various changes to the specification are also believed to be reasonably self-explanatory, and warrant no further discussion.

Amendment to the Drawings

Applicants propose to amend Fig. 3 of the drawings as indicated in red on the indicated sketch. The change here is to have reference numeral 56 refer to the interface optical element, and to use reference numeral 55 to refer to the optical fiber, as discussed *supra* with respect to the changes to the specification. Clearly, these proposed changes to the drawing do not seek to add "new

matter". A new drawing figure to replace Fig. 3 is submitted herewith in the appendix.

Amendment to the Claims

As noted above, this application was filed with twenty-four original claims. Of these, examination has been conducted with respect to claims 1-12, and claims 13-24 are understood to have been withdrawn from consideration at this time. Applicants have recently filed a divisional application to prosecute the subject matter of claims 13-24.

Of the examined claims (*i.e.*, claims 1-12), only claims 1 and 7 are presented in independent form. Claims 2-6 are severally dependent, either directly or indirectly, on independent claim 1. Similarly, claims 8-12 are severally dependent, again either directly or indirectly, on independent claim 7. Accordingly, independent claims 1 and 7 are the broadest of the examined claims. If these claims distinguish patentably from the prior art, then each of their respective trailing dependent claims must similarly so distinguish. *Ex parte Leavell*, 212 USPQ 762 (Bd. App.1979) [where a dependent claim is based upon an allowed parent claim, such should be considered allowable for the same reasons as the parent claim]; *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988) [dependent claims are non-obvious if the independent claims from which they depend are non-obvious].

Claim 1 is directed toward a fiber optic rotary joint, whereas claim 7 is directed toward a reversion prism assembly that might be used in such a fiber optic rotary joint. Thus, claim 1 is directed to a combination, and claim 7 is directed to a sub-combination.

For the Examiner's convenience, clean copies of claims 1 and 7, as amended herein, are reproduced herebelow, and are annotated with parenthetical reference to the corresponding parts, portions or surfaces of the disclosed embodiment for the purposes of illustration:

"1 (currently amended): A fiber optic rotary joint (10), comprising:
a housing (16) defining an internal cavity (18) adapted to be at least partially filled with a fluid having a variable index of refraction;
first and second optical collimation arrays (20, 20) disposed on opposite sides of said internal cavity for transmitting optical signals therethrough parallel to an axis (44);
a reversion prism (22) disposed within the internal cavity between said first and second optical collimation arrays, said reversion prism having opposite end faces (42, 42) intersected by said axis;
and
an interface optical elements (40, 40) having mating surfaces (46, 46) engaging said end faces, each interface optical element including an optically-flat surface (48) facing into said chamber and arranged in a plane perpendicular to said axis; each interface optical

element being so configured and arranged as to permit optical signals to be transmitted along said axis without being refracted by the variable index of refraction of said fluid." (Parenthetical reference added)

"7 (currently amended): A reversion prism assembly , comprising:
a reversion prism (22) having opposite end faces (42, 42) intersected by an axis (44), each of said end faces being disposed at a nonorthogonal angle relative to said axis; and
an interface optical elements (40, 40) having mating surfaces (46, 46) engaging said end faces, each of said interface optical elements having an optically-flat surface (48) that is orthogonal to said axis." (Parenthetical reference added)

Looking first at claim 1, this is now directed to the combination of a fiber optic rotary joint. That joint is required to have a housing defining an internal cavity that is adapted to be at least partially filled with a liquid having a variable index of refraction. Support for this inserted limitation may be found in paragraph [0009], which indicated that "the internal cavity has been filled with a fluid whose optical properties, including its index of refraction, may vary with changes in temperature and/or pressure". Of course, the fluid may be a liquid, a gas, or a combination thereof.

Claim 1 then continues by requiring the inclusion of first and second optical collimation arrays disposed on opposite sides of the internal cavity. For consistency, Applicants' attorney would prefer to refer to these as opposite ends of the cavity, however the word "sides" was used in the specification. Applicant would change "opposite sides" to -- opposite ends -- in claim 1 and in the specification, if the Examiner feels this desirable. This might possibly be achieved by way of an Examiner's Amendment. In any event, the claim then continues that the first and second collimation arrays are disposed on opposite sides of the cavity for transmitting optical signals through the cavity along an axis.

Claim 1 then continues to require the inclusion of a reversion prism disposed within the internal cavity between the first and second collimation arrays. The reversion prism is required to have opposite end faces intersected by the axis.

In paragraph [0005] of the specification, the applicant took pains to define what he might be a reversion prism:

"A reversion prism is a trapezoidal prism defining a longitudinal axis therethrough and having opposed end faces that are disposed at equal but opposite angles relative to the longitudinal axis."

Claim 1 then goes on to define interface optical elements having mating surfaces engaging the end faces of the reversion prism, with each interface optical element including an optically-flat

surface facing into the chamber and arranged in a plane perpendicular to the axis, and with the further limitation that each interface optical element is so configured and arranged as to permit optical signals to be transmitted along the axis without being refracted by the variable index of refraction of the fluid. Support for this limitation is clearly found in paragraph [0041] of the specification, wherein the following sentence appears:

"In this regard, the interface optical element generally includes a mating surface 46 that is attached to the respect end surface of the reversion prism, such as by means of an optically-transparent epoxy."

The final clause of claim 1 is support by paragraphs [0038] and [0039] of the specification, as reproduced below.

[0038] One or more springs 38, such as one or more helical springs, may also be disposed between the cover 24 and the reversion prism 22. Likewise, one or more springs (not shown), such as a leaf spring, may be disposed between a respective side wall 28 of the stage and the reversion prism. These springs serve to bias the reversion prism into contact with the stage and the various alignment elements carried by the stage and reduce, if not eliminate, subsequent movement of the reversion prism once the reversion prism has been appropriately aligned. As shown in FIG. 1, the first and second optical collimation arrays 20 and the reversion prism would all be exposed to and in contact with any fluid that fills the internal cavity 18 defined by the housing 16. In the absence of the present invention, therefore, variations in the temperature and/or pressure to which the fiber optic rotary joint 10 is exposed would cause the density and, in turn, the optical properties, such as the index of refraction, of the fluid to vary which would disadvantageously alter the manner in which the optical signals are refracted upon entry into and exit from the first and second collimation arrays and the reversion prism, thereby reducing the alignment between respective optical fibers of the first and second optical collimation arrays.

[0039] According to the present invention, the fiber optic rotary joint 10 also includes one or more interface optical elements. As described in detail below, the interface optical elements may be disposed proximate to one or both of the first and second optical collimation arrays 20 and/or proximate the reversion prism 22. The interface optical element includes an optically-flat surface that is adapted to contact the fluid. As known to those skilled in the art, an optically-flat surface introduces optical distortions that are small relative to the wavelength

of the optical signals. Thus, optical signals may be transmitted between the interface optical element and the fluid that fills the internal cavity 18 of the housing 16 in an orientation that is normal to the optically-flat surface without causing the optical signals to refract. As such, variations in the optical properties of the fluid, such as variations in the index of refraction of the fluid, will not alter the manner in which the optical signals propagate and, as such, will not disadvantageously alter the alignment of the respective optical fibers of the first and second optical collimation arrays.

Independent claim 7 is directed to the sub-combination of a reversion prism assembly *per se*, such as might be used in the fiber optic rotary joint defined by claim 1. This assembly is required to have a reversion prism and interface optical elements having mating surfaces engaging the end faces of the reversion prism, as discussed above. The final clause refers to the fact that each of the interface optical elements has an optically-flat surface that is orthogonal to the axis passes through the end faces of the reversion prism. This feature (*i.e.*, that the optically-flat surface be normal or perpendicular to the axis along which the signals are transmitted) enables the signals to be transmitted through the optical rotary joint, without refraction that might otherwise be attributable to, or caused by, the variable index of refraction of the fluid(s) in the chamber. The reason for this is that such optical signals enter the first interface optical element and leave the second interface optical element through surfaces that are perpendicular to the axis of signal transmission.

Applicant's attorney respectfully submits that the combination defined by claim 1, and the sub-combination defined by claim 7, are not prospectively taught or suggested by any of the prior art references cited by the Examiner.

Fukahori *et al.* (U.S. Pat. No. 4,872,737) appears to disclose a rotary joint having a trapezoidal prism therein. However, there are no elements analogous to the "interface optical elements" of the present invention that are secured to the end faces of the trapezoidal prism. Indeed, optical signals emitted into the prism-containing chamber are specifically shown as encountering the end faces of the prism at an angle, and being refracted into the prism.

Verma *et al.* (U.S. Pat. No. 6,646,745) simply discloses a prism arrangement in which light signals are reflected within the prism such that they exit in a direction different from the direction from which they entered. However, this reference does not teach or suggest that "optical interface elements" may be secured to the end faces of a trapezoidal prism so as to render the apparatus insensitive to changes in the index of refraction of the fluid(s) in the chamber.

Ames (U.S. Pat. No. 5,568,578) appears to disclose yet another form of optical rotary joint having a trapezoid prism. However, this reference shows that signals are directed at, and leave from, the inclined end faces of the trapezoidal prism, at an angle. Hence, they will be refracted by changes in the index of refraction in the chamber. Clearly, this reference does not teach or suggest that any

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type of "optical interface element" should be secured to, or otherwise mounted on, the end faces of a trapezoidal prism so as to desensitize the fiber optic rotary joint, or the reversion prism assembly, to variation in the index of refraction of the fluid(s) in the chamber.

Han *et al.* (U.S. Pat. No. 6,704,143) simply discloses two relatively shiftable abutting prisms. The transverse position of these prisms may be varied or changed so as alter the optical path length.

The remaining references appear to be even less pertinent, and need not be further discussed.

In view of the clarifying changes that were made to claims 1-12, and, further, in view of the fact that none of the prior art references cited by the Examiner, either singly or in combination, appears to teach or suggest that "interface optical elements" can be secured to the inclined end faces of a trapezoidal prism so that the optical signal will enter and exit the reversion prism assembly through optically-flat surfaces that are perpendicular to the axis of signal transmission, such that the device will be thereafter immune to variations in the index of refraction of the fluid in the chamber. These features are simply not shown or suggested by any of the prior art references cited by the Examiner.

In view of the foregoing, it is believed to be unnecessary to review the specific bases for the Examiner's initially rejection of the claims.

Accordingly, independent claims 1 and 7 are believed to distinguish patentably from all of the art-of-record. Since these two independent claims distinguish patentably from the prior art, it necessary follows that each of their trailing dependent claims must similarly so distinguish.

Accordingly, claims 1-12, as amended herein by the clarifying changes made in this Amendment, are believed to distinguish patentably from the prior art. This statement is, of course, without prejudice to prosecution of withdrawn claims 13-24 in the recently-filed divisional application.

This Amendment is believed to be fully responsive to the Office Action of January 24, 2006; is believed to squarely address each and every ground for objection or rejection raised by the Examiner; and is further believed to materially advance the prosecution of this application toward immediate allowance. No additional fee is believed to be due. However, if any such additional fee is found to be due and deficient, kindly change the same to our Deposit Account No. 19-3320.

Accordingly, formal allowance of claims 1-12, as amended herein, is courteously solicited.

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Respectfully submitted,

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I certify that this correspondence is being deposited with the United States Postal Service as first class mail, postage prepaid, in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on April 17, 2006.

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Appendix

A proposed replacement sheet with the corrections to Fig. 3 is attached.